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Excerpt Minutes of Proceedings of The Institution of Civil Engineers.
Vol. cvi. Session 1890–91. Part iv.
Edited by James Forrest, Secretary.

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Published by the Institution,
25, GREAT GEORGE STREET, WESTMINSTER, S.W.
[Telegrams, "Institution, London." Telephone, "3051."]
1891.

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THE INSTITUTION OF CIVIL ENGINEERS.

Sect. II.—OTHER SELECTED PAPERS.

(*Paper No. 2551.*)

"Proposed Railway through Siberia."[1]

By William Martin Cuningham, Assoc. Inst. C.E.

The project of a railway through Siberia connecting the shores of the Pacific with Europe has been for many years a subject of discussion and interest in Russia. At last there seems a prospect of this stupendous undertaking becoming a reality, and orders have been given to commence at the eastern terminus, Vladivostock, so that the first sod may be turned there by the Tsarevitch during his present visit to this distant part of his future dominions. But the line now to be made from Vladivostock northwards to Graffsky is only a small section of the Siberian Railway, and no decision has yet been arrived at as regards the route to be taken by the line proper, nor the order in which its different divisions should be attempted.

There never was any difference of opinion as to where the Siberian Railway should terminate, but it is still a matter of dispute where it should begin. There are three points to which the railways of European Russia now extend, and from which the line might start (Plate 8). The advocates of the three different routes eastwards agree that the line must pass through the town of Nijni Udinsk, some 275 miles N.W. of Irkutsk, as from thence round the Lake of Baikal there can be but one route.

The documents presented by the Minister of Communications to the Council of Ministers describe fully and impartially this important railway scheme, which will open up the wealth of Siberia, the trade with China, and connect Russia with her distant colonies on the Pacific, from which she is practically shut off at present. It has been proposed to begin the western section from:—

1. Tiumen, the present terminus of the Ural Railway. This line however is not connected with the railway system of Russia, but starts from Perm, on the River Kama, which is frozen for half the year, and to complete the land communication a line would have to be built of 650 miles between Perm and Nijni Novgorod, crossing four large rivers, and costing about £11,200 per mile. It

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[1] Three articles on this subject appeared in *The Times* on the following dates, Feb. 14, April 3, and May 30, 1891.—Sec. Inst. C.E.

is admitted that the Ural Railway has been made in a perfunctory fashion merely to serve the mining districts, and that it has gradients of 1 in 150 and curves of 1,050 feet radius, rendering it unsuitable as part of a great transit line. If continued eastwards from Tiumen, this railway would run to Tomsk, passing through bog-land and over numerous rivers; and as there is water communication between these towns by the rivers Irtish and Obi, the additional connection would be superfluous, and to the deprivation of other districts which have no such natural advantages.

2. By beginning the Siberian Railway at Orenburg, the southernmost of the three rival routes, direct communication would certainly be attained through Samara, but eastward of that place it must pass through 1,000 miles of desert absolutely without population, water, or vegetation, subject to storms of sand and snow, and, on reaching the longitude of Tomsk, it would have to be carried through a mountainous district at great cost.

3. The third alternative is that most favoured by the Minister of Communications, and will probably be adopted.

It is to start from Miask, to which point a railway is at present being made from Slatoust, the terminus of the Samara Ufa line. The distance from Moscow to the common point at Nijni Udinsk, through Miask, would be shorter than the Tiumen route by 527 miles, and 478 miles shorter than by way of Orenburg. And the cost, to the point at which the Tiumen and Miask lines would join, viz., at the River Tom, near Tomsk, is less in the latter case by some £7,400,000.

At first it was understood to be the intention of the Government to use the existing waterways, thus starting from Kasan to proceed to Perm by the Kama, thence to Tiumen by the Ural Railway, from Tiumen to Tomsk by water, and then to build a railway to Irkutsk. From Irkutsk to the eastern shore of the Baikal Lake the traffic would proceed by steamer, from some point, probably the village of Misova, a railway would be constructed to strike the Shilka, a tributary of the Amur at Stretyinsk, whence the route would be by the Amur and Usuri rivers to Graffsky, and finally by railway to Vladivostock. But as the rivers for at least half the year are frozen, and transit by them is extremely slow, it is now decided that the Siberian Railway is to be one through line, or at the worst broken only at the larger rivers by ferries, to be replaced in time by permanent bridges. It seems almost certain that the Siberian Railway will begin at Miask, and from this point it has the advantage of opening up a populous and very fertile country at the start, and moreover in the Yenisei district there are fewer engineering difficulties than by either of the other projects. It is also proposed to make a connecting line of some 135 miles from Chelyabinsk to Ekaterinburg, which would be of great advantage to the mining districts through which the Ural River runs, in providing them with supplies of grain. The Chelyabinsk corn is celebrated all over Russia. In the Ural nothing is grown.

Building any railway is merely a matter of time and money; and in considering how to set about the construction of the Siberian line it is proposed first to commence with three sections, the Central Siberian, from Tomsk to Irkutsk; the Trans-Baikal, from Misova to Stretyinsk on the Amur; and the Usuri section, from Vladivostock to Graffsky.

Passing in review the entire route proposed from west to east, the first section to be considered is that from Miask to the River Obi. The line now being constructed from Ufa to Slatoust will be continued past the Miask gold mines belonging to Astashoff's heirs; then, inclining to the south, it leaves the Lake Ilmen on the left, ascends the last range of the Ural, a spur of the Ilmen mountain, attaining the summit at the seventh verst. From this point it descends into a flat country, crosses twice the River Bischkiel, in one case by a bridge of 105 feet, and finally reaches Chelyabinsk, 63 miles from Miask. So far the route has been properly surveyed, but beyond eastwards to Omsk only flying reconnaissances have been made, sufficient however to make it certain that from the base of the Ural range for 1,000 miles to the River Obi, Western Siberia, is a plain in which a railway can easily be constructed, the numerous rivers which must be bridged constituting the only difficulty. As far as this point the line passes through a fertile country fairly populated, but when the River Obi is crossed the route becomes difficult, intersects numerous rivers and poor land. The town of Omsk is not of commercial importance, and by passing it at a distance of 33 miles heavy work would be saved and the main line would be that much shorter. It is proposed to cross the River Irtish near Sargatki, choosing the most convenient point for a bridge and landing pier, as this river of 2,400 miles in length, with a population of four millions living within its basin, is naturally of importance.

From Kainsk the line, to avoid morasses, must follow the present port road, crossing the Obi and the Tom at a point some 50 miles above Tomsk. It is necessary to leave the town of Tomsk on one side, as to carry the line through it would entail gradients and curves not desirable, and the river could not be crossed advantageously at the town, where the width of its bed varies, whereas at the point proposed it is confined within definite limits. A branch line can be made in the delta formed by the Obi and Tom.

The districts through which this section runs produce grain in abundance, particularly in the west, but they have little market for it; at present only some 250,000 tons per annum find their way into European Russia. Wheat, in 1887, at Kainsk fetched 2*s.* per cwt., and oats 1*s.* 2*d.* Not only would the western markets benefit by the railway, but if it were extended to the Trans-Baikal districts, which depend on supplies from China, there would be a large traffic to them. At Blagovestchensk rye-flour costs, at the present rate of exchange, 16*s.* 6*d.* per cwt. and wheat 24*s.* 9*d.* Manufactured goods are sent from Moscow and Nijni by water to Perm, thence by rail to Tiumen, and by water to Tomsk, at a cost of £10 to £15 per ton, and at Tomsk they have to be warehoused till the winter roads permit of carriage further east. Although the bulk of the grain would be moved by water from the districts deprived of such means of transit, it is estimated that 250,000 tons of grain, 60,000 tons of manufactured goods, tea, firs, skins, wools, and large quantities of cattle, would pass over the Western Siberia section annually.

There is an unlimited supply of horses, and wood and stone in abundance, and some 5,000 experienced labourers, who are engaged in building the present railways, would be available for the commencement of the Western Siberian section.

The estimated cost, according to the Ministry of Ways and Communications, from Chelyabinsk to the River Obi, including rails and rolling stock, is £4,500 per mile of single line. If a pontoon bridge over the Irtish were substituted for a permanent iron structure the cost would be reduced to about £4,300 per mile.

The Central Siberian section from the River Obi to Irkutsk would run through high plateaux, intersected by deep ravines, gradually rising to the Baikal lake, which is 1,587 feet above sea-level. The first part for 250 miles to Achinsk, over a plain with maximum grades of 1 in 800, and curves 1,750 feet, to Krasnoiarsk, 115 miles, crossing the Yenisei range, and water-shed inclines of 1 in 150 and 1,050 feet curves, would be necessary.

From Krasnoiarsk through Kansk to Nijni Udinsk the line would intersect, in an east to south-east direction, the high sources of the Yenisei, Kan, Biriusa and Uda rivers, which all flow to the north. In these 360 miles no tunnels would be needed, but two viaducts of 150 feet in height, each under 1,000 feet in length, and bridges of 3,150 feet over the Yenisei, and 2,800 feet over the Obi, would be the heaviest work.

From Nijni Udinsk the line would run by the valley of the Moob and Oka rivers, following the port roads over a subsequent tract of hilly country, and finally by the valley of the Angar reach Irkutsk.

Of stone, wood, and ballast there is a superabundance on this section, but only one ironworks at Nicolaeviksky, which, from its position, could supply to some extent girder work and rail fastenings, but not rails. The works are 8 miles from the River Oka, which falls into the Angara, and Irkutsk can be reached from there by water.

The Abakansky works of Permikine, on the River Abakan, a tributary of the Yenisei, are infinitely better situated, having oil and fuel on the spot, and communication with Krasnoiarsk, but owing to the failure of the owner they have been closed since 1888.

The population of the district averages 1·52 per square verst, and the greatest difficulty in constructing this section would be to obtain labourers, who would have to be brought from the west; their pay would necessarily be high—some 35 per cent. above what it is in European Russia, and victualling costs from £40 per annum per man in the west, to five times that amount in the eastern divisions of the line.

The climate permits of work being begun only towards the end of May, finishing in September, and it may be reckoned that there are altogether 100 working days.

The present traffic between Tomsk and Irkutsk is about 56,000 tons annually of tea and manufactured goods; but between these points there is a great difference in the cost of the necessaries of life. At Tomsk rye costs 67*s.* per ton, and dry oats 46*s.* 6*d.*, whilst at Irkutsk the prices are 232*s.* and 206*s.* 6*d.* respectively. Thus a considerable traffic eastward in cereals, westwards in tea, and both ways in passengers and mails might be expected.

A naive suggestion put forward in the official report is that, as the cost of bringing tea from Irkutsk to Nijni Novgorod at is present £26 1*s.* per ton, and it would cost 1 rouble per pood less by railway, this amount might be added to the duty payable on its entering Russia. On the same principle the carriage from Hankow to Irkutsk costs now about £109 5*s.* per ton; and if, by the projected railway, £12 8*s.* per ton would cover it, another little sum of something like £80 per ton might be appropriated by the Minister of Finance and nobody be the wiser or the worse!

The estimated cost of this Central Siberian section is, including rails and fastenings and permanent bridges over the Yenisei and Obi, £6,812 per mile, making a total of £9,000,000 sterling for the line from the Obi to Irkutsk. The rivers and mountains have, generally speaking, to be cut at right angles, as the rivers incline northwards; for the division to Achinsk the heaviest grades would not exceed 1 in 800, but on towards Irkutsk they would be 1 in 150.

The next section round the Baikal lake, according to the surveys made, promises to be difficult, owing to the two ranges of mountains which separate Irkutsk from the lake. The route determined on follows the valley of the River Irkut for 62 miles, the line being cut out on the edge of the hills, rounding the protecting ridges by curves down to 850 feet radius, and entailing a tunnel of some 250 feet in length. Thence for 25 miles the line would be of a mountainous character rising to a tunnel 4,200 yards long, required to cut the Zirkiginsky range, and to save a distance of 20 miles which would otherwise have to be traversed. Descending by the valley of the Kultushny river, hemmed in by precipitous cliffs 350 feet in height, the line will run along the banks of the Baikal lake to the landing-place Misova. This short section will cause much work; the shores of the lake are steep, and the line will have to be cut on these banks where there is no beach. Wooden bridges are proposed, as in the absence of plans the actual requirements as to spans are difficult to estimate; the tunnel will not cause much trouble, and probably will not require lining.

The shores of the lake are covered with wood; stone and sand abound. There are absolutely no inhabitants, and this section of the railway could not be touched till the Central and Trans-Baikal sections were made. The cost is only approximately estimated at £13,700 per mile.

The Trans-Baikal section will connect the Baikal lake and the Amur system. At present there is steam communication for half the year, and over the ice for three and a half months, between Irkutsk and the eastern shores. The port of Misova is considered to be the most advantageous, as Verkhnie Udinsk is closed two months earlier; from this part the line will run along the edge of the lake, leaving it by the valley of the River Selenga, which it will cross eventually by a bridge 3,115 feet long, reaching the town of Verkhnie Udinsk at the junction of that river with the Uda.

Thence it will rise with the River Uda to the 267th mile, to the valley of the Pogromry, and to the plain from which the River

Lena takes its source. Still rising, it will cross the watershed of the Lena and Uda, and at the 326th mile attain its greatest altitude on one of the ridges of the Yablonovy mountains, viz., 3,703 feet above sea-level, only 28 feet below the level of the Brenner pass in the Tyrol, and 238 feet above the Mont Cenis tunnel. The main Yablonovy range is encountered at the 397th mile, but at a less height than its spur; this is the division of the Lena and Amur rivers flowing into the Arctic and Pacific oceans. From this watershed the line by constant declines of 1 in 120 will descend into the valley of the Chita. In order to avoid crossing the basins of four rivers, it will turn to the south to the valley of the Shilka, passing by the lake Holban (near which there is good coal). For some part of the way the track will have to be cut in the sides of the cliffs, but further on it will descend by a series of natural terraces to the Nercha river. Crossing this by a bridge of 850 feet the railway will end on the left bank of the River Shilka, opposite the town of Stretyinsk.

The Trans-Baikal section has to cross but one navigable river, the Selenga. The worst decline is 1 in 120 for 14 miles from the Yablonoff range into the valley of the River Chita, as the line runs east; beyond this 1 in 800 is the heaviest gradient.

Wood and stone abound, and of sand there is sufficient; all the iron would have to come from Russia *viâ* the Amur and Shilka rivers. The gold mines monopolize all the available labourers, whose wages and keep are very costly.[1] The climate is very severe and variable, the range of temperature being as much as 75° Fahrenheit within twenty-four hours. At Verkhnie Udinsk the highest recorded temperature in the years 1886 to 1888 was 115°, the lowest 74° below freezing point, and on the Yablonovy mountains 11° of frost in the summer is common.

It is a first principle of the Russian Government that everything to be used in making the Siberian railway must come from and be made in Russia. Thus a pood of iron costing 5*s.* 2*d.* at Odessa (£16 3*s.* 4*d.* per ton), would by the time it reached Stretyinsk cost 9*s.* 2*d.* per pood (£28 10*s.* 4*d.* per ton), and if carried further to Verkhnie Udinsk by land 11*s.* 6*d.* per pood. Of cement alone it is estimated that 72,000 casks will be wanted on the Trans-Baikal section, costing 5 roubles (11*s.* 9*d.*) at Novorossisk on the Black Sea; each cask would cost at Stretyinsk £2 17*s.*, or at Verkhnie Udinsk £7 2*s.* 10*d.*!

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[1] In the whole district of 491,000 square versts there are but 545,000 souls; and of these one-third are the natives who are utterly incapable of hard work, and only fit for drivers. The mining population is very fluctuating; for example, at Nerchinsk, in July the average is 2,500, and in February 850 men, their wages varying from 1*s.* 6*d.* to 4*s.* 3*d.* per diem. The period during which masonry work could be carried on would not exceed seventy-five days in the year.

The Amur section of the Siberian railway as laid down on the accompanying map from Stretyinsk to Graffsky is still unexplored, but surveys will be taken in hand this year. From what little is known of the country, however, it is not expected to present any great difficulty. There is great difference of opinion as to whether the line coming so near to the Chinese frontier as is proposed is judicious from the military point of view. A sudden raid on it would paralyze the whole system.

The Usuri Vladivostock section from Graffsky to the sea is actually begun. It runs for the most part through mountainous country, relieved only by some level ground on the side of the lake Hinka, and is parallel to the unexplored Sihot Aline mountains, which range from south-west to north-east. The valley of the Usuri river is being colonized from Russia, and already the fairly fertile soil is producing corn to supplement the food supplies of the eastern settlements.

At present the communication from Khabarovka to Vladivostock is in summer by the Usuri, the Sungracha and lake Hinka, but in spring and autumn the inhabitants are cut off from the world except by telegraph. Every year the route becomes more difficult as the rivers are silting up, the lake Hinka has fallen 7 feet in the last twenty-eight years, so that it is high time a railway should be made.

From Vladivostock the line runs north-north-east till it strikes the Usuri river, following the valley of which it proceeds due north. The starting-point is not actually in the town of Vladivostock, where there is not sufficient level space, and which might be within the range of modern guns. The terminus has therefore been placed about 2 miles away in the valley of the Pervy; the line skirts the shores of the Amur Gulf, crosses the peninsula Muravieff, and by two short tunnels will traverse this rugged district.

Further north the projected route presents no difficulties, attaining its greatest height 100 feet above sea-level at the watershed of the Okhotsk and Japan seas. From thence it descends to the valley of the Lefu, which flows into the lake Hinka, crosses this river by a bridge of 420 feet, and the Usuri at the 327th verst by a bridge of 1,750 feet, and follows the line of the Usuri in a northerly direction to the Graffsky station.

A branch of 5 versts (3½ miles) to the harbour of the Golden Horn at Vladivostock is also to be constructed. The total length from Vladivostock to Graffsky is 393 versts (262 miles), and the worst grade is 1 in 800, and 1,000 feet curves.

All the materials for the line would of course come from Russia by sea to Vladivostock at one end, by Nicolaevsk, and the Amur, and Usuri, to the present terminus at Graffsky. The climate is trying in summer, being very damp, with south-east monsoons; and in winter the dryness and cold are extreme. Bridges must be made of iron, and structures, dwelling houses, &c., of stone to stand this climate. There are no workmen and no roads; the River Usuri is sometimes available for steamers of 6 feet draught, while at other times there is scarcely enough water for a rowing boat.

It is intended to appropriate 10½ desatines (about 28 acres) per lineal verst; the land almost all belongs to the government, except in the immediate neighbourhood of Vladivostock, where compensation to the amount of £30,000 is allotted. The total cost of the railway to Graffsky, including rolling stock, is estimated at £2,768,000, £10,500 per mile, and it is expected that the line will be ready in three years.

The question of employing Chinese labour has been raised, but the Ministry seem to think that the competition with Russians would create a feeling better avoided, and an order has just been issued (April 20) that the convicts are to do the work, receiving one-tenth of the determined rates of pay, the balance to be expended in looking after them.

The width of the embankments is to be 16 feet 9 inches; in cuttings the slopes will depend on the nature of the soil; the rails are to be 48½ lbs. English per yard; sufficient rolling stock is to be kept for two mixed trains and four goods trains daily. The line is built especially to facilitate the transport of troops from the Amur to Vladivostock, and the termination proposed at this port is considered by the military authorities to be too open to attack from the sea, so that it is still a point in dispute whether Nikolsk, a valley further inland, should not be chosen for the terminus.

The great question as regards the Siberian railway in general is whether the line is to be for transit, or to serve local interests, and it is evident that only valuable merchandise could be carried such long distances by land; grain and such goods would still go by water where possible. But nobody pretends that the railway is primarily for commercial purposes; it is to serve the state, and is as necessary as keeping up a standing army in Europe.

At present it takes eighteen months to transport troops from the Volga to Vladivostock over Siberia, whereas by rail it would be a matter of thirty days.

The climate is a matter of serious consideration. Frost is not supposed to go into the ground more than 7 feet; but where tested round the Baikal sections, at a depth of 10 feet, the soil has been invariably found frozen hard. Thus the foundations of structures would be on frozen soil. Along the whole line the temperature for days at a time is sometimes 72° Fahrenheit of frost, and in some parts more than 90°. The averages for the middle of January recorded at Chelyabinsk 31° Fahrenheit of frost, between Omsk and Baikal 34° to 40°, beyond Baikal 45° to 58°, on the Usuri from 43° in the north to 25° at Vladivostock. The lowest temperature ever recorded was at Irkutsk, on the 17th of December, 1860, 99° Fahrenheit of frost, but on the 15th of December, the thermometer stood at 20°, whilst on the 4th of December it was actually 4° above freezing point.

From Chelyabinsk to Omsk there is much snow; and when the storms come on the peasants unharness the horses, tilt up the shafts, and lie on their loads, while everything gets covered with the snow. In the valley of the Yenisei the snow is also heavy, and is accompanied by storms of wind; further east, beyond Baikal, but little snow falls, travelling is done in sledges over the frozen rivers and in carts over the ground. It is intended that the level of the railway shall, including ballast, never be less than 3 feet 9 inches above the plains; and as protection portable hurdles will be fixed, and larch trees planted along the line as these grow well and quickly.

By allotting tracts of land along the line colonists may be attracted. The breadth of the line is to be 15 feet 6 inches in hilly country, and 16 feet 9 inches in ordinary parts, with 48½ lbs. rails; the gauge will be of the width usual in Russia, namely 5 feet. Locomotives of 50 tons may be used, which on inclines of 1 in 800 would draw forty to forty-five wagons of the usual weight, and on mountainous grades up to 1 in 100 the trains would be limited to twenty-two wagons.

There is every desire to keep inclines and curves within reasonable limits, as the Russians have had some sharp lessons in this respect, notably on the Donetz railway, the working of which is limited and unsatisfactory. The cost of earth-work is all round estimated at 3r. 50 per cubic sajeen of 7 feet, and stone-work at 12r., ordinary iron-work 5r. 50 per pood (36 lbs.) at Verkhnie Udinsk.

It is generally considered that the line would be most economically constructed if begun at both ends; at least, such is the opinion of all but the Minister of Finance, who thinks it would be lighter for the finances of the Empire to proceed by sections. At present there is an accumulation of contractors' material and certain number of experienced labourers engaged on the Ufa-Slatoust railway, who would be available if the western point of departure were fixed. The Minister of Ways and Communications considers he could make the line to Achinsk in five years, and to Irkutsk in four or five years more, taking advantage of the water communication to work at various points on the line.

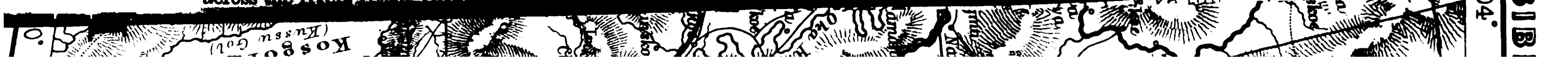
The population from the Ural mountains to Lake Baikal is Russian; further east, aborigines of a type anything but inclined to work; the labour question being one of the greatest difficulties. Broadly speaking the Siberian railway has, owing to public opinion, become one of the urgent questions of the day in Russia, but the conflicting interests of the different departments of Imperial Domains, Finance, and Ways and Communications, will undoubtedly tend to delay a final settlement of the route or order of work till the Tsar issues an absolute order overruling all parties.

The special information contained in the Map (Plate 8) is derived from materials furnished by the Author.

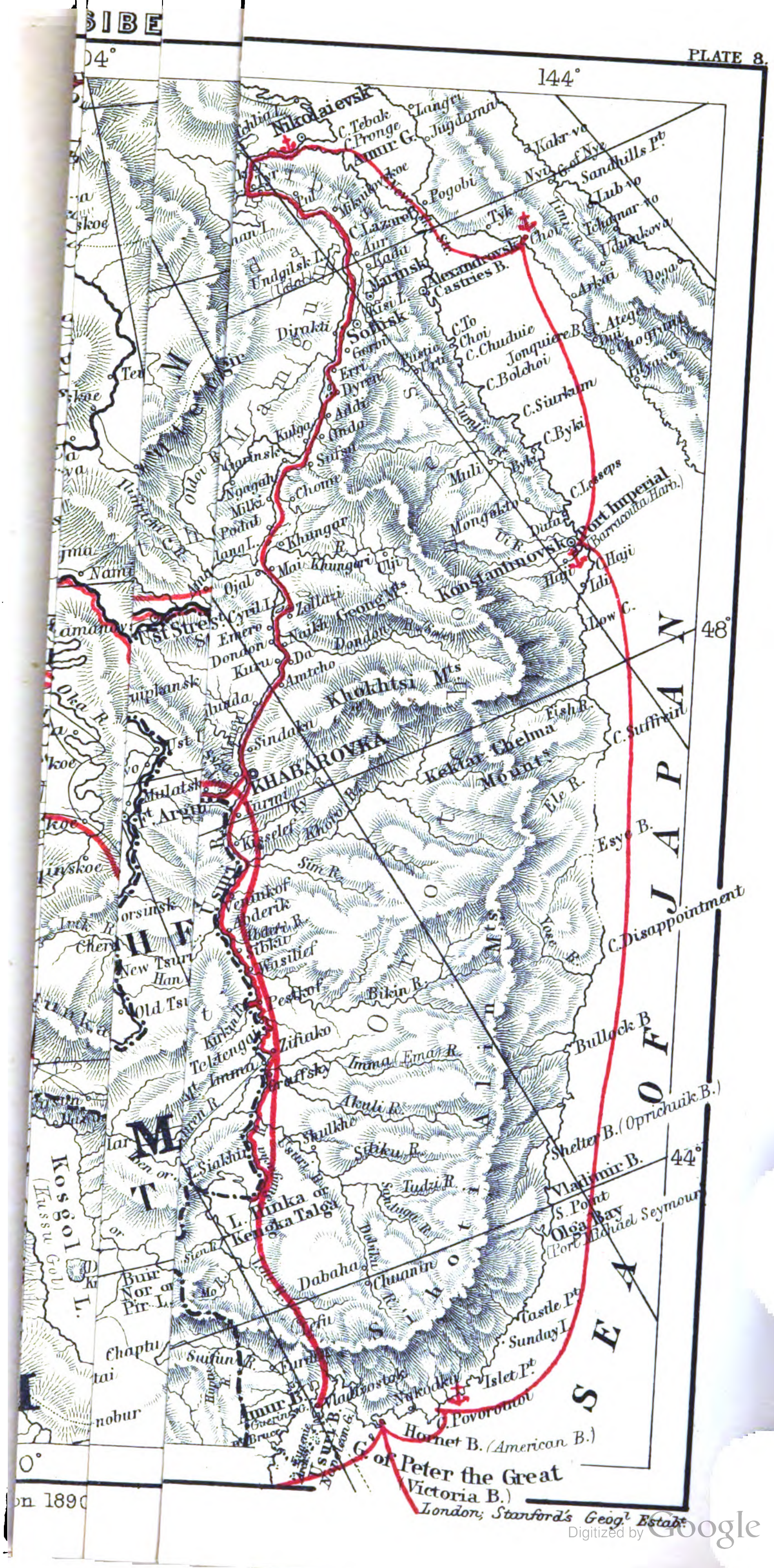
COST OF BUILDING SIBERIAN MAIN RAILWAY.

Names of Section.	Length.			Cost of Work without Rails, Fastenings, or Running Stock, and Delivery of same.		Cost of Rails, Fastenings, and Running Stock, and Delivery of same.		Total Cost.	
	Chief Lines. Miles.	Branches.	Total Miles.	Total.	Per Mile.	Total.	Per Mile.	Total.	Per Mile.
				£.	£.	£.	£.	£.	£.
1. Miask-Chelyabinsk	62⅔	..	62⅔	301,815 15 4	3,205 10 7	125,108 7 1	1,330 18 10	426,424 2 4	4,536 9 5
2. Chelyabinsk-Obi, with branches to Omsk and rr. Tobal, Eshim, Irtish, and Obi .	970*	50*	1,020*	2,895,120 0 0*	1,892 4 7*	2,082,600 0 0*	1,361 3 6*	4,977,720 0 0*	3,253 8 3*
3. Obi-Irkutsk, with branches to Tomsk and rr. Tom, Yenisei, and Angara .	1,110	60	1,170	5,870,290 4 8	3,344 18 10	3,097,058 16 6	1,764 14 1	8,967,349 1 2	5,109 12 11
4. Irkutsk-Misova .	195⅓	..	195⅓	2,100,506 9 5	7,168 18 10	586,000 0 0	2,000 0 0	2,686,506 9 5	9,168 18 10
5. Mysova Stretyinsk . . .	667⅓	5⅓	672⅔	4,257,540 17 8	4,219 10 7	2,184,888 4 8	2,165 8 3	6,442,434 2 4	6,384 18 10
6. Stretyinsk-Graffsky	1,600*	..	1,600*	11,294,117 12 11*	4,705 17 6*	5,082,352 18 10*	2,117 12 11*	16,376,470 10 11*	6,823 10 7*
7. Graffsky - Vladivostok . . .	256	6	262	1,984,652 18 10	5,052 16 6	783,061 5 11	1,993 12 11	2,767,647 1 2	7,046 9 5
	4,861⅓	121⅓	4,962⅔	28,703,548 18 10*	3,840 9 5	13,941,069 12 11	1,865 5 11	42,644,618 11 9	5,705 15 4

REMARKS.—1. Cyphers against which are placed asterisks are calculated approximately, investigations not having been made previously between the points shown. 2. The calculation of cost of the Siberian Railway is made assuming permanent bridges are built across the rivers Irtish, Ob, Y[illegible]



Engineer, P. Sokoloff.



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